

# Ozone Student Activity Book

## I. Introduction

Ozone is similar to oxygen that we breathe. Air contains oxygen molecules that are made up of two oxygen atoms combined together ( $O_2$ ). Ozone is a molecule made up of three oxygen atoms combined together ( $O_3$ ). Ozone is everywhere in our atmosphere, but most of it is at the altitude that airplanes fly. It is poisonous if inhaled, but it also shields us from ultraviolet (UV) light that would give us skin cancer. Ozone is therefore one of those things that we can't live with and can't live without, but if it's in the right place, it does us a great service. Naturally, there is very little ozone at ground level, and very much of it in the upper atmosphere. Start the activity to learn more about ozone's effects.

### Get Info Objectives

1. Describe where the ozone layer is.
2. Explain natural formation of ozone.
3. Explain how CFC's destroy ozone.

### Gather Data Objectives

1. Interpret graphs of ultraviolet radiation, ozone concentration, and chlorine concentration.
2. Explain why artificial chemicals are more destructive to ozone than are naturally occurring chemicals.
3. Describe ozone's harmful effects at ground level.

## Application Objectives

1. Describe the economic effects on people affected by ozone depletion.
2. Describe economic effects of banning CFCs.
3. Justify international ozone-related laws.

Before doing anything else, add the NOAA Research "Ozone" page to Bookmarks or Favorites on your web browser.

- From the NOAA Research Ozone main page, click "Get Info."

## II. Get Info

### A. Location of Ozone

- Click on the "Aeronomy Lab" site.
- Scroll down to the graphic "Regions of the Atmosphere."
- Read the information, interpret the picture, and answer the following question:

1. Where is the ozone layer?
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- Click back to return to the Ozone "Get Info" web page.

### A. Ozone Loss

- Click on the "Ozone Depletion" site.
- Read the page and answer the following questions:



1. What does CFC stand for?

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2. What were CFCs used for?

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3. What are three chemical properties of CFCs?

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4. What specific atom of the CFC molecule damages ozone?

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- Click "Back" to return to the NOAA Research "Ozone" home page, or choose "Ozone" from your Favorites or Bookmarks.
- Click "Gather Data."

### III. Gather Data

#### A. Ozone Eaters

- Click on the "Common Questions" site.

1. How is ozone distributed in the atmosphere?

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2. What is the "Ozone Hole" ?

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3. Besides CFCs, what other molecules destroy ozone?

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- Click "Back" to return to the Ozone "Gather Data.1" web page.

### **B. Proof of Damage**



- Click on the "Evidence" site.
- Look at the figure and answer the following questions:



1. As the concentration of chlorine rises, what happens to the concentration of ozone?

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- Click "Back" to return to the Ozone "Gather Data.1" page.

### **C. Natural vs. Artificial**



- Click on the "Chlorine Sources" site.



1. Since nature produces chlorine all the time, why do only artificially produced chlorine molecules cause trouble?

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2. What percent of the chlorine in the atmosphere can be attributed to nature? \_\_\_\_\_

- Click "Back" to return to the Ozone "Gather Data.1" web page.
- Click "Forward" at the bottom of the page.



#### D. Total Ozone Loss

- Click on the "October Ozone Hole" site.
- Scroll down to the graph.

1. Compute the percentage of ozone in Antarctica in 1993 compared to the amount of ozone we had in October in 1957.

- a. Estimate the total ozone in 1957 and record it below.

\_\_\_\_\_ Dobson units.

- b. Estimate the total ozone in 1993 and record it below.

\_\_\_\_\_ Dobson units.

- c. Divide the 1993 value by the 1957 value.

- d. Move the decimal two places to the right to get the percentage of ozone that we have now.





- Click "Back" to return to the Ozone "Gather Data.2" web page.

### E. Sunburn Effects



- Click on the "Ultraviolet Radiation" site.



1. If the concentration of ozone decreases 30%, how much additional UV radiation will reach the surface of the earth? \_\_\_\_\_

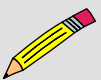


- Click "Back" to return to the Ozone "Gather Data.2" web page.

### F. Future Outlook



- Click on the "Ozone Treaty" site.



1. What is expected to happen to the ozone layer during your lifetime?  
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- Click "Back" to return to the Ozone "Gather Data.2" web page.

### G. Usual Suspect



- Click on the "Rural Ozone" site.



1. What problems are associated with ozone at ground level?

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2. How are we producing ozone at ground level?

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3. How can we decrease the ozone concentrations at ground level?

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4. What changes in our lives can we make to reduce ozone concentrations at ground level?

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- Click "Back" to return to the Ozone "Gather Data.2" web page
- Click "Return" at the bottom of the page, or choose "Ozone" from your Bookmarks or Favorites.
- Click on "Application."

## IV. Application

### A. Economic Problems

- Click on the "Health" site.
- Read the page, think about the impacts of ozone depletion and answer the following question:

1. Remembering that a decrease in ozone causes the Earth's surface to receive an increase in ultraviolet rays, describe the economic effects on people affected by ozone depletion. Include medical problems in humans, crops, and livestock, etc.

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- Click "Back" to return to the Ozone "Application.1" web page.

### B. Ozone Formation

- Click on the "Ozone Shield" site.
- Read the "Ozone and Humankind" section.





1. Recall that the oxygen we can breathe exists as a molecule of two oxygen atoms bound together ( $O_2$ ). Draw how three oxygen molecules can turn into two ozone molecules ( $O_3$ ). Include all three steps and show everything necessary for the reaction to occur.



- Click "Return" at the bottom of the page, or choose "Ozone" from your Bookmarks or Favorites.
- Click on "Enrichment."

## V. Enrichment Activities

### A. Research



1. Use resources on the Internet to write a report on electric cars. Include how they could help lower nitrous oxide emissions. Include the energy sources we could use to provide power for the cars if we want to use non-polluting sources of energy.
2. Use resources on the Internet to write a report on fuel cells. Include the use of water electrolysis to make hydrogen from water.
3. Research the relationship of ultraviolet radiation to skin cancer.



4. Research the relationship of ultraviolet radiation to cataracts.
5. Find out how ozone is created by lightning.
6. Research the change in the shape of the Antarctic ozone hole every five years since 1957. Draw the change and label each one.

### **B. Newspaper Activities**

1. Collect articles related to ozone and summarize each one.

### **C. Related Web Sites**

1. NOAA's Office of Global Programs Ozone site  
<http://www.ogp.noaa.gov/library/rtnf92.htm>
2. Climate Monitoring and Diagnostics Laboratory  
<http://www.cmdl.noaa.gov/>
3. Ozone  
<http://earthobservatory.nasa.gov/Library/Ozone/>
4. Ultraviolet Radiation  
<http://earthobservatory.nasa.gov/Library/UVB/>
5. Ozone Depletion  
<http://www.epa.gov/docs/ozone/>
6. Stratospheric Ozone and Human Health  
<http://sedac.ciesin.org/ozone/>
7. The Ozone Hole Tour  
<http://www.atm.ch.cam.ac.uk/tour/>

